PB-217 810

AIR POLLUTION MEASUREMENTS IN DUQUESNE, PENNSYLVANIA, SEPTEMBER-OCTOBER 1963

Seymour Hocheiser, et al

Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

October 1964

DISTRIBUTED BY:

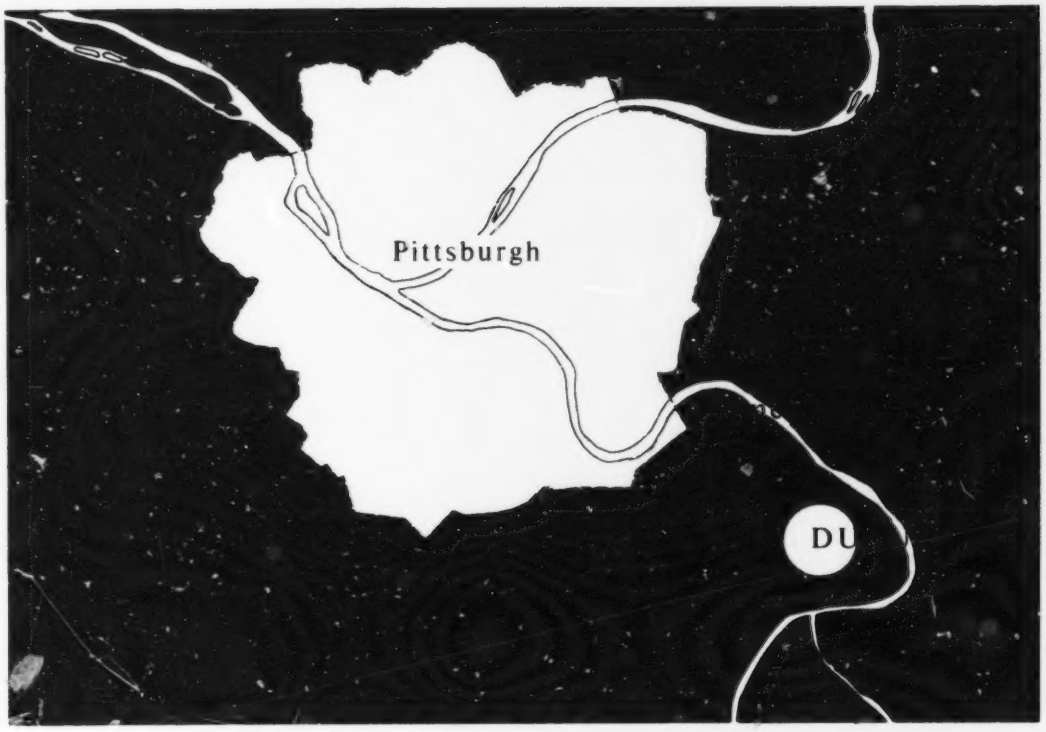
NTIS

National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

A64-43
PB 217 810

Air Pollution Measurements in Duquesne, Pennsylvania

RECEIVED
MAR 31 1965
LIBRARY
SANITARY ENGINEERING CENTER
CINCINNATI, OHIO



Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
U S Department of Commerce
Springfield VA 22151

ALLEGHENY COUNTY HEALTH DEPARTMENT
BUREAU OF AIR POLLUTION CONTROL

U.S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
Public Health Service
Division of Air Pollution

Air Pollution Measurements in Duquesne, Pennsylvania

September-October 1963

Seymour Hochheiser and Melvin Nolan
Public Health Service
Division of Air Pollution
Technical Assistance Branch

and

Herbert J. Dunsmore, Chief
Allegheny County Health Department
Bureau of Air Pollution Control

Details of illustrations in
this document may be better
studied on microfiche.

U. S. Department of Health, Education and Welfare
Public Health Service
Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio 45226

October 1964

I

Technical Study Staff

ALLEGHENY COUNTY HEALTH DEPARTMENT

Herbert J. Dunsmore, Chief, Bureau of Air Pollution Control

Harry W. Wilker, Principal Chemist

Walter G. Popiel, Assistant Analyst

Lorenz B. McConnell, Laboratory Technician

PUBLIC HEALTH SERVICE

Seymour Hochheiser, Project Director, Division of Air Pollution, Technical Assistance Branch

Melvin Nolan, Chemist

William J. Basbagill, Chemist

Thomas E. Kreichelt, Chemical Engineer

Fred Jentsch, Physical Science Technician

Acknowledgments

Paul A. Humphrey, Meteorologist, U.S. Weather Bureau Research Station, Robert A. Taft Engineering Center, Cincinnati, Ohio, for assistance in analysis of weather data and preparation of the meteorological sections of this report.

The City of Duquesne Board of Education for providing space, utilities, and assistance in installing the mobile air sampling laboratory.

Contents

INTRODUCTION 1

CONCLUSIONS AND RECOMMENDATIONS 2

CONDUCT OF STUDY 3

DISCUSSION OF RESULTS 4

Particulate Pollutants 4

Soiling Index 4

Total Suspended Particulates 8

Gaseous Pollutants 10

Sulfur Dioxide 10

Total Oxidants 12

Carbon Monoxide 13

Carbon Dioxide 14

Nitric Oxide - Nitrogen Dioxide 14

Total Aliphatic Aldehydes 15

High Pollution Days 15

Meteorological Observations 16

REPRESENTATIVENESS OF METEOROLOGICAL CONDITIONS DURING THE STUDY 19

Wind Speed 19

Degree-Days 19

Precipitation 19

Visibility 20

REFERENCES 21

APPENDIX - TABULATION OF AIR POLLUTION MEASUREMENTS . . . 23

Introduction

A cooperative, 1-month, pilot study of ambient air quality was conducted in Duquesne, Pennsylvania, from September 23 to October 30, 1963, to define more precisely the existing and potential community air pollution problems and to serve as a basis for improvement of the air resource management program in the area. Participating in this study were the Allegheny County Bureau of Air Pollution Control and the Public Health Service, Division of Air Pollution. Various gaseous and particulate pollutants were measured on a continuous basis. The principal facilities and equipment used were contained in a mobile air sampling laboratory provided by the Public Health Service. Duquesne and vicinity is a heavily industrialized area primarily engaged in iron and steel manufacture. It is located on the Monongahela River about 12 miles upstream (southeast) from downtown Pittsburgh.

Air quality data are needed to determine (1) plans for air resource management; (2) effects of air pollution control regulations and other factors influencing pollutant emissions; (3) relationships of levels of air pollution to its effects, such as those related to the health of humans and animals, damage to vegetation and property, and other economic and aesthetic losses; (4) trends in air pollution over the years; (5) criteria in developing air quality standards; and (6) plans to provide certain protection of the public from exposure to hazardous concentrations by means of an air pollution alert system.

A cooperative, short-term, air-quality, pilot study was conducted previously in Allegheny County[1] with the mobile laboratory. The test site for the earlier study was situated at 40th Street and Penn Avenue, about 3 miles north of downtown Pittsburgh. This earlier study characterized pollution conditions in an area that may be described as commercial, residential, and light industrial.

Some of the data obtained in the Duquesne study, such as concentration range of air contaminants, relationship among levels of air pollutants, and relationship of meteorological measurements and air pollution measurements, are presented here. Also planned are scientific papers concerning the measurement methods used and the relationships among them for the technical literature.

Conclusions and Recommendations

Air pollution levels measured in this brief study are of sufficient magnitude to justify further planning and development of the air resource management program serving the Duquesne area.

Conclusions based on the data of this study are as follows:

1. Pollution due to particulate matter is a major problem. Atmospheric particulate concentrations exceeded 290 micrograms per cubic meter 50 percent of the time. Soiling index values were rated as heavy 50 percent of the time. Atmospheric concentrations of certain metals far exceeded the national urban average as would be expected because of the proximity of the sampling site to a major steel mill.
2. Pollution due to sulfur dioxide is a major problem. Hourly sulfur dioxide levels reached 0.66 ppm during a period of relatively poor atmospheric ventilation.
3. Photochemical-type smog was not detected nor was it expected during the fall season. The potential for photochemical smog in Duquesne is greatest during the summer months.

Recommendations based on this study are as follows:

1. The resources available to the Allegheny County Bureau of Air Pollution Control should be increased to permit a more extensive air resource management program.
2. A continuing air monitoring program should be instituted at strategic sampling sites throughout the area to augment the data obtained in this study, to determine seasonal and yearly trends of pollution, and to provide information upon which to base control program decisions.

Conduct of Study

The mobile laboratory was situated on the campus of Duquesne High School, Fourth and Grant Streets, Duquesne, Pennsylvania, throughout the study period from September 23 to October 30, 1963. Meteorological equipment was located on the roof of the school building. Samples were collected continuously with automatic sampling, analyzing, and recording equipment. Manual sampling techniques were also employed, and 30-minute, short-term samples were collected periodically during the daytime. Sulfur dioxide, oxidants, nitrogen dioxide and nitric oxide, carbon monoxide, carbon dioxide, aldehydes, total suspended particulates, and metals in atmospheric particulate samples and soiling index were determined. Wind speed and direction, temperature, and humidity were also measured.

The unit was operated by personnel of the Allegheny County Bureau of Air Pollution Control and Technical Assistance Branch, Division of Air Pollution. The mobile laboratory was open to visitors at specific hours so that interested people would have the opportunity to examine this facility and discuss the problems of air pollution in Duquesne with representatives of Allegheny County and the Public Health Service. The data obtained were processed with manual, semiautomatic, and automatic methods.[2] The data produced on strip charts by automatic recording air analyzers were integrated on an hourly basis and tabulated on data forms by means of the Oscar "J", a semiautomatic device for taking data from strip chart records. The data were key punched manually onto cards for use in an electronic digital computer programmed to file and store the data on a master magnetic tape, and produce tables of raw data and final reports (correlations, means, standard deviations, percentage frequency distribution, etc.).

Discussion of Results

Whenever available, data from continuous, automatic, air-quality monitoring instruments are reported here; and when not available, data obtained by manual methods are reported. The measurement program, including apparatus, methods, sampling time, and frequency of sample collection, is similar to that detailed in the earlier air quality study in Pittsburgh. The sampling and analytical methods used are listed in Table A-9 of the Appendix.

PARTICULATE POLLUTANTS

Total atmospheric-particulate pollutants were estimated by two methods, soiling index as measured by light obscuration of filtered samples and total suspended particulate loading on a weight basis. Additionally, particulate samples were analyzed spectrographically for content of several metals.

Soiling Index

Soiling index is used for (1) estimating the amount of atmospheric suspended particulates of small particle size that cause decreased visibility owing to light scattering and absorption and (2) estimating the capability of particulates in the atmosphere to cause soiling of walls, furniture, drapes, buildings, etc. The values are recorded in Cohs* per 1,000 linear feet of air.

Air samples are drawn through filter paper, and the reduction in light transmitted through the filter paper that results from the collected particulate is recorded. The State of New Jersey Department of Health has adopted an adjectival rating system to describe the soiling index.[3] The results obtained in Duquesne at 2-hour sampling intervals continuously throughout the study were classified according to a modification of this rating system proposed by the Allegheny County Bureau of Air Pollution Control, and are given in Table 1.

---

*One Coh unit is the quantity of particulate matter that produces an optical density of 0.01 on filter paper.

Table 1. FREQUENCY OF OCCURRENCE OF SOILING INDEX VALUES

Cohs/1,000 linear feet of air	Rating[a]	Frequency of occurrence, %
0 - 0.9	Light	17
1.0 - 1.9	Moderate	31
2.0 - 2.9	Heavy	20
3.0 and greater	Very heavy	32

[a]Based on the rating system of the Allegheny County Bureau of Air Pollution Control.

The values ranged from 0.1 to 9.3 Cohs/1,000 linear feet of air with an arithmetic mean of 2.6 and a geometric mean and median of 1.9 (Table A-1, Appendix). The highest 24-hour average was 6.1. The cumulative frequency of soiling index values is shown in Figure 1.

The average diurnal variation in soiling index data is shown in Figure 2. Highest values occurred from 0600 to 1000 hours. Soiling index fluctuations are related to variations in the dispersive capabilities of the atmosphere as determined by wind speed and vertical temperature gradient and to variations in wind direction and pollutant emission rates.

The relationship of soiling index values and wind directions along with gaseous pollutant concentrations and wind directions are shown graphically in Figure 3. As shown in Figure 3-B, highest concentrations occurred when the direction of the wind was south or southeast, or when wind speeds were less than 2 mph (calm). The number of samples collected when the wind direction was east and northeast were insufficient to give valid data, and these cases are excluded from the above statement.

The relationship between atmospheric particulate levels measured by optical density of filtered deposits (soiling index) and by weight is shown in Figure 4. This relationship is characteristic for this community for the months of September and October. It should not be used in air quality studies conducted elsewhere.

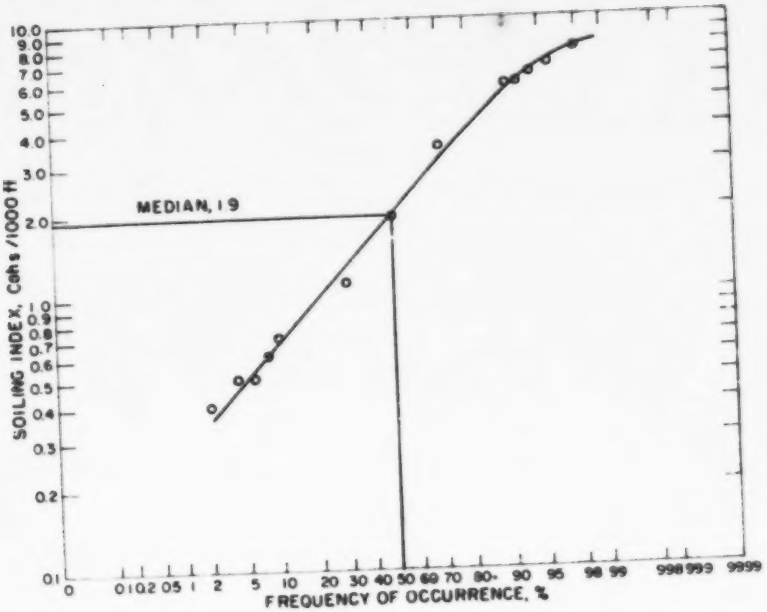


Figure 1. Frequency distribution of soiling index values.

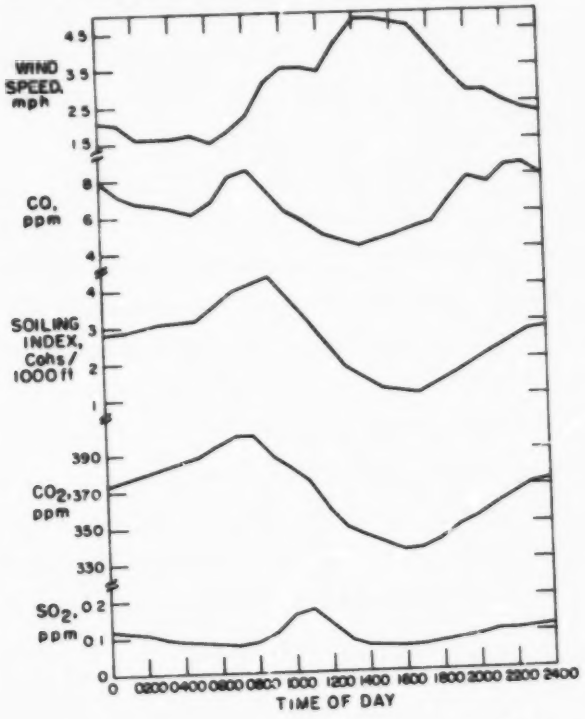


Figure 2. Diurnal variation of several pollutants with wind speed.

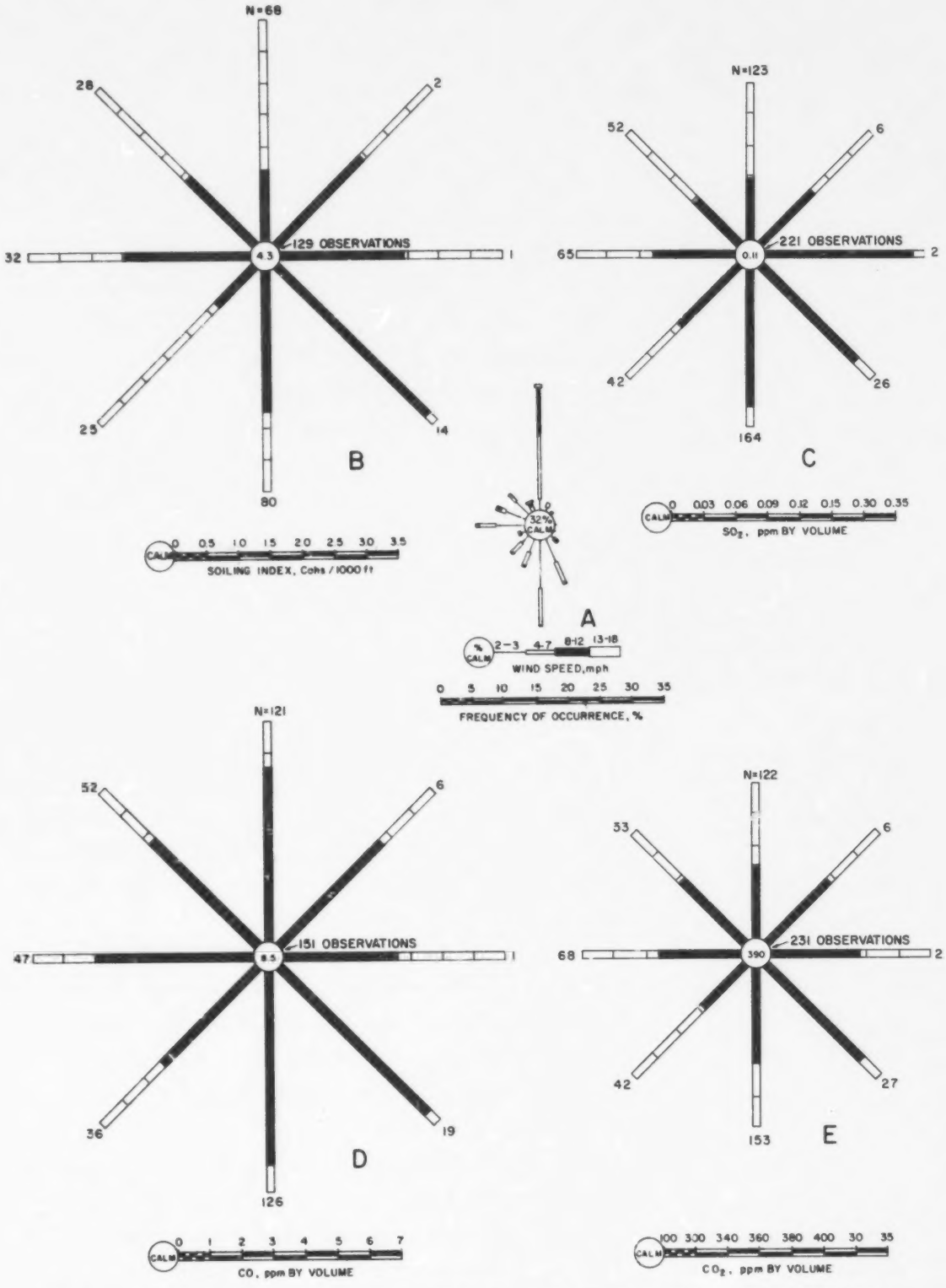


Figure 3. Variation of average pollutant concentration with wind direction (Numbers at the end of direction radials refer to number of 1-hour samples except for soiling index, which were 2-hour samples.).

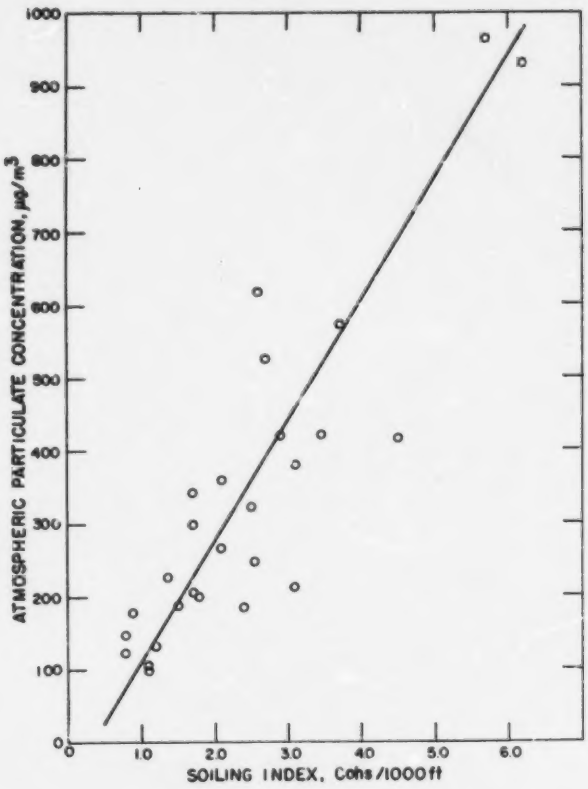


Figure 4. Relationship of atmospheric particulate concentration and soiling index.

Total Suspended Particulates

Particulates in the atmosphere arise from combustion of fuels, industrial processes, wind erosion, and other sources. Aerosols can also be formed in atmospheric photochemical reactions.

Daily average atmospheric particulate loading was determined on a weight basis from integrated 24-hour samples obtained by high-volume filtration through glass fiber filters. Particulate concentrations during the study period ranged from 99 to 963 micrograms per cubic meter with an arithmetic and geometric mean of 361 and 298, respectively (Table A-2). The cumulative frequency distribution is shown in Figure 5 (median = 290 $\mu g/m^3$).

Metals were determined spectrographically on particulate samples composited according to total atmospheric particulate concentration. The relationship between percent composition of 15 metals and total atmospheric particulate concentration is shown in Table 2. The percent composition of antimony, cadmium, and manganese tend to increase with increasing total atmospheric

Table 2. RELATIONSHIP OF PERCENT COMPOSITION OF METALS IN ATMOSPHERIC PARTICULATE SAMPLES TO TOTAL SUSPENDED PARTICULATE CONCENTRATION

Atmospheric particulate concentration range, $\mu g/m^3$	Percent composition[a]														
	V	Sb	Zn	Cr	Ni	Mo	Co	Bi	Cd	Mn	Pb	Sn	Fe	Cu	Ti
900 and over	0.003	0.02	0.003	0.08	0.03	0.02	0.02	0.001	0.02	1.1	0.4	0.005	6.3	0.04	0.02
500 - 899	0.002	0.01	0.002	0.04	0.02	0.03	<0.001	0.002	0.007	1.1	0.3	0.003	2.8	0.02	0.04
400 - 499	0.002	0.01	0.002	0.03	0.02	0.02	<0.001	0.005	0.003	1.1	0.6	0.002	2.1	0.04	0.02
300 - 399	0.002	0.01	0.001	0.02	0.02	0.03	0.06	0.001	0.006	0.1	0.4	0.003	2.1	0.02	0.02
200 - 299	0.004	0.01	0.003	0.04	0.04	0.03	<0.001	0.001	0.005	0.0	0.3	0.004	2.6	0.04	0.03
150 - 199	0.006	<0.01	0.002	0.04	0.04	0.06	<0.001	0.001	<0.001	0.4	0.1	0.006	2.7	0.03	0.03
149 and less	>0.002	<0.01	0.007	0.03	0.03	0.01	<0.001	0.001	0.001	0.6	0.3	0.009	3.3	0.04	0.03

[a] Percent composition = $\frac{\text{Wt of metal}}{\text{Wt of total particulates}} \times 100.$

particulate concentration. The percent composition of the other metals measured did not generally increase significantly with total atmospheric particulate concentration except that the highest percent composition of iron and chromium occurred at total atmospheric particulate concentrations of greater than 900 micrograms per cubic meter. The atmospheric concentration of metals in particulate samples are compared to the National urban average[4] in Table 3. The metals content of the atmosphere of Duquesne is substantially higher than the National average, particularly for manganese, iron, and chromium.

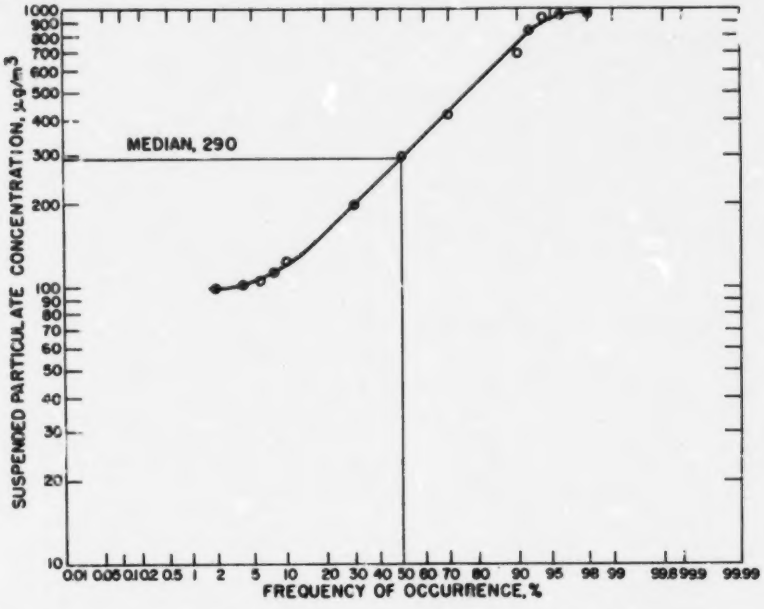


Figure 5. Frequency distribution of suspended particulate concentrations.

The Oregon standard[5] for total suspended particulate on a weight basis (250 $\mu g/m^3$ above normal background for industrial areas) was exceeded on 14 of the 29 days that measurements were made (background was assumed to be 50). In Pittsburgh at the National Air Sampling Network station located in the downtown area, the average suspended particulate concentration for the autumn months is 147 and 128, arithmetic and geometric mean, respectively (1957-1963).[4] Particulate pollution levels measured during this study in Duquesne averaged more than twice as much as those in Pittsburgh.

GASEOUS POLLUTANTS

Sulfur Dioxide

An automatic electroconductivity analyzer was used to determine atmospheric sulfur dioxide concentrations continuously during the study. Average hourly con-

Table 3. COMPARISON OF AVERAGE ATMOSPHERIC CONCENTRATIONS OF METALS IN DUQUESNE AND THE NATIONAL URBAN AVERAGE

Metal	Average concentrations of metals in atmosphere, $\mu g/m^3$		Approximate factor, Duquesne
	(9/27/63 - 10/29/63)	National urban average (1957-1960)	national urban average
Manganese	3.99	0.10	39.9
Lead	1.7	0.5	3.4
Tin	0.02	0.05	0.4
Iron	16.6	2.5	6.6
Copper	0.11	0.07	1.6
Titanium	0.12	0.06	2.0
Zinc	1.10	0.48	2.3
Chromium	0.230	0.047	4.9
Nickel	0.130	0.040	3.2
Molybdenum	0.11	n.a.	n.a.
Cobalt	0.006	n.a.	n.a.
Bismuth	0.003	n.a.	n.a.
Cadmium	0.043	n.a.	n.a.
Antimony	0.069	n.a.	n.a.
Vanadium	1.10	n.a.	n.a.

n.a. indicates data are not available.

centrations ranged from 0.01 to 0.66 ppm with an arithmetic and geometric mean of 0.10 and 0.08, respectively (Table A-3). The greatest 30-minute average concentration was 0.78 ppm, and the greatest 24-hour average concentration was 0.17. The cumulative percentage frequency of occurrence is shown in Figure 6 (median = 0.08). Highest concentrations generally occurred from 1000 to 1200 hours (Figure 2) and when the wind direction was south or southeast or at wind speeds of less than 2 mph (calm), as shown in Figure 3-C. Elevated sulfur dioxide levels were associated with severe air pollution episodes, during which excess deaths were reported, in London and in New York City. The 24-hour average sulfur dioxide concentrations was about 0.5 ppm or greater. The California ambient air quality standard, 1 ppm for 1 hour or 0.3 ppm for 8 hours is based on plant damage. Sulfur dioxide is also associated with materials degradation, such as corrosion of metals and deterioration of limestone. Neither the California standard nor the concentrations reported during severe air pollution episodes in London or New York were exceeded during the sampling period.

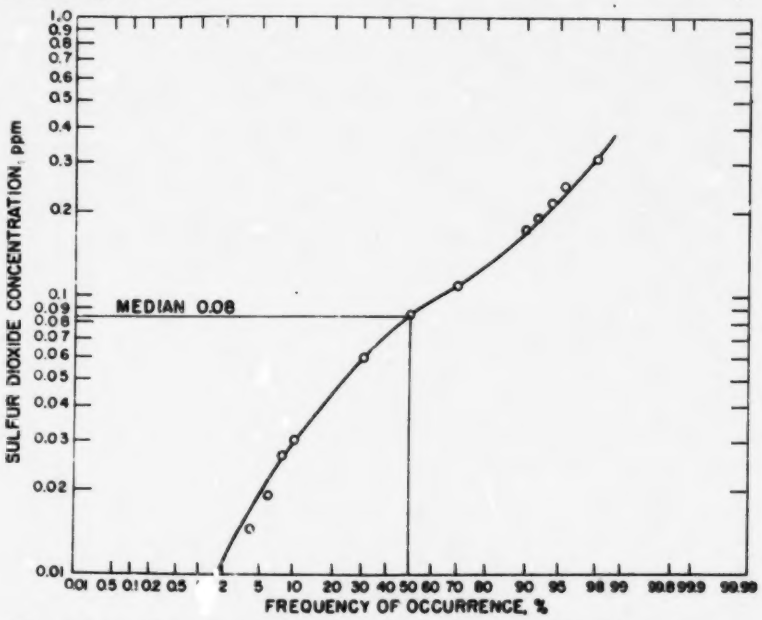


Figure 6. Frequency distribution of sulfur dioxide concentrations.

Total Oxidants

Oxidants were measured continuously using an automatic coulometric analyzer with a chromic-oxide-treated prefilter to prevent the interference of sulfur dioxide. The highest hourly concentration of 0.02 ppm indicated the

absence of photochemical-type smog during the period of measurement. The potential for oxidant formation is related to availability of solar energy (intensity and duration of sunlight) since oxidants are produced in reactions involving hydrocarbons, nitrogen oxides, and sunlight. A greater photochemical smog potential would be expected during the summer months. The manifestations of photochemical smog, namely, eye irritation, decreased visibility, and plant damage, occur at oxidant concentrations of 0.15 ppm and greater.

Carbon Monoxide

Atmospheric carbon monoxide concentrations were measured continuously throughout the study by means of a nondispersive infrared analyzer. Average hourly concentrations varied from 2.1 to 20.5 ppm with an arithmetic and geometric mean of 6.5 and 5.9, respectively (Table A-4). The highest 30-minute average concentration was 21.0 ppm, and the highest 24-hour average concentration was 10.2 ppm. The cumulative percent frequency of occurrence of carbon monoxide concentrations is shown in Figure 7 (median = 5.4). Highest concentrations generally occurred between 0700 and 0900 hours and 2000 and 0100 hours (Figure 2). These diurnal fluctuations in carbon monoxide concentrations are influenced by variations in the dispersive capability of the atmosphere and in emission strength and wind direction. The principal sources

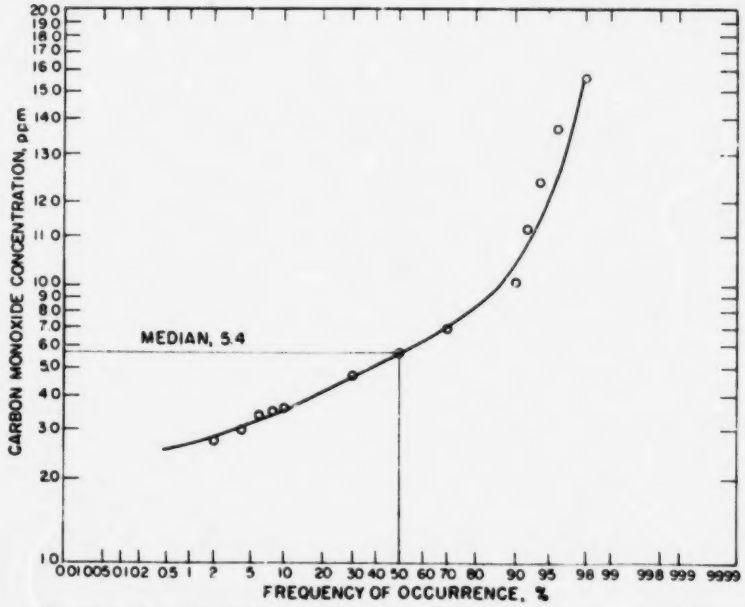


Figure 7. Frequency distribution of carbon monoxide concentrations

of carbon monoxide are automotive exhaust and certain industrial plants such as steel mills.[6,7] Concentrations of carbon monoxide did not vary substantially with wind direction. Concentrations were higher when wind speeds were lower than 2 mph as shown in Figure 3-D. Carbon monoxide interferes with the oxygen-carrying ability of the blood by preferentially combining with hemoglobin. The California ambient air quality level for carbon monoxide, 30 ppm for 8 hours or 120 ppm for 1 hour, was established so that community air pollution would contribute not more than 5 percent carboxyhemoglobin.

Carbon Dioxide

Since carbon dioxide is discharged in all combustion processes in large amounts and since combustion processes are responsible for a large part of the total pollutants emitted to the air over a community, carbon dioxide concentrations are useful as an index of air pollution levels in general and an index of the dispersive capability of the atmosphere. Carbon dioxide levels did in fact correlate with the dilution potential of the atmospheric (as determined by wind speed) and pollution levels (Figure 2). Average hourly carbon dioxide concentrations determined continuously throughout the study with a nondispersive infrared analyzer varied from 296 to 495 ppm with an arithmetic and geometric mean of 368 and 366, respectively (Table A-5). The highest 30-minute

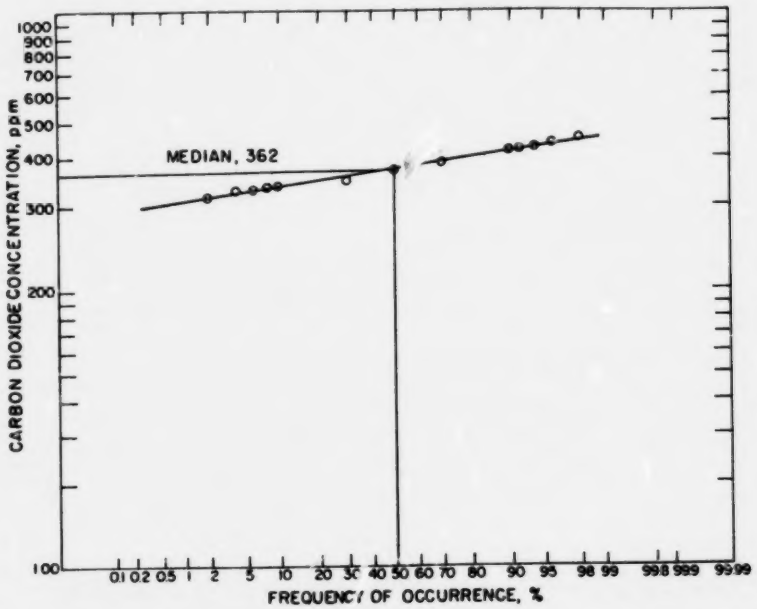


Figure 8. Frequency distribution of carbon dioxide concentrations.

concentration was 495 ppm, and the highest 24-hour concentration was 418 ppm. The cumulative percentage frequency of occurrence of carbon dioxide concentrations is shown in Figure 8 (median = 362). Highest concentrations of carbon dioxide occurred when wind speeds were lower than 2 mph or when wind direction was southeast, as indicated in Figure 3-E.

Nitric Oxide - Nitrogen Dioxide

Four 30-minute air samples were collected daily by the Saltzman method for nitric oxide and nitrogen dioxide determination.[8,9] The range of nitric oxide concentrations was from less than 0.01 to 0.27 ppm with an arithmetic and geometric mean of 0.05 and 0.03, respectively (Table A-6). Highest concentrations generally occurred at 0830 hours and lowest at 1530. Nitrogen dioxide concentrations ranged from 0.01 to 0.18 ppm with an arithmetic and geometric mean at 0.05 and 0.04, respectively (Table A-7). Highest concentration generally occurred in the morning. Nitrogen oxides are important reactants in the production of photochemical smog. Some authorities believe that photochemical smog will not occur if the combined nitrogen oxide concentration is below 0.10 ppm. Nitrogen dioxide alone can cause reduction in visibility and fading of dyed fabrics.

Total Aliphatic Aldehydes

Four 30-minute air samples were collected daily by the MBTH method for total aliphatic aldehyde determination.[10] This measurement includes formaldehyde, aceteldehyde, acrolein, proprionaldehyde, and other water-soluble aliphatic aldehydes. Aldehyde levels (expressed as formaldehyde) ranged from <0.01 to 0.19 ppm with an arithmetic and geometric mean of 0.06 and 0.05, respectively (Table A-8). Highest concentrations generally occurred at 0830 hours. Aldehydes, mainly formaldehyde and acrolein, are suspected of being major contributors to eye irritation. In Los Angeles the total atmospheric aldehyde concentration on smog days in 1960 varied from 0.13 to 0.24 ppm (1-hour samples), the formaldehyde and acrolein concentrations varied from about 0.05 and 0.005, respectively. It is suspected that atmospheric aldehydes cause leaf damage to certain plants when aldehyde concentration exceeds 0.2 ppm for 2 hours.

HIGH POLLUTION DAYS

A high air pollution potential advisory was announced by the Weather Bureau Research Station at the Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, for an area including the city of Duquesne for the period

October 14-18, 1963. Such advisories are announced when an air mass is expected to stagnate for 36 hours or more and result in poor atmospheric dispersion conditions. Poor atmospheric dispersion conditions are reflected by low wind speeds and atmospheric temperature inversion. They are usually associated with relatively great accumulation of air pollutants. Atmospheric stagnation incidences occur most frequently in the Greater Pittsburgh area including Duquesne during the month of October. Korshover's study of the 21-year period from 1936 to 1956 showed the occurrence of seven cases lasting 4 days or more during October.[11]

Pollution levels present during periods of atmospheric stagnation are an indication of the severity of the air pollution problem associated with each particular pollutant. Pollution measurements during days of high air pollution potential are given in Table 4. These data indicate that pollution due to particulate matter and sulfur dioxide are the most significant problems. Daily average total atmospheric suspended particulate concentrations varied from 572 to 963 micrograms per cubic meter, and daily average soiling index varied from 4.1 to 6.1 Cohs per 1000 feet. Maximum hourly average sulfur dioxide concentrations ranged from 0.21 to 0.78 ppm. The levels of other pollutants measured on these days were also generally proportionately higher than the mean concentration of these pollutants for all samples collected from September 27 through October 29, 1963.

The effect of particulate pollution on visibility is shown pictorially in Figure 9. The photographs are of the view to the east from the roof of Duquesne High School at 1030, October 17, 1963 (6.3 Cohs/1000 ft, 60% relative humidity) and at 1500, October 24, 1963 (0.2 Cohs/1000 ft, 84% relative humidity). The visibility was about 1/4 mile on October 17 and more than 5 miles (the maximum distance viewable) on October 24.

METEOROLOGICAL OBSERVATIONS

The mobile sampling unit is equipped with a wind speed and direction recorder and a hygrothermograph (for temperature and relative humidity records). The meteorological data used in this report for relating air pollution measurements and meteorological factors were those obtained at the special weather station established on the roof of Duquesne High School.

Table 4. ATMOSPHERIC MEASUREMENTS ON DAYS OF RELATIVELY HIGH AIR POLLUTION

Pollutant and unit of measurement	Date, October 1963															
	14			15			16			17			18			
	Maximum concentration	Daily average	Ratio of daily average to arithmetic mean	Maximum concentration	Daily average	Ratio of daily average to arithmetic mean	Maximum concentration	Daily average	Ratio of daily average to arithmetic mean	Maximum concentration	Daily average	Ratio of daily average to arithmetic mean	Maximum concentration	Daily average	Ratio of daily average to arithmetic mean	Arithmetic mean, all samples (Sept. 27-Oct. 29)
Soiling index,[a] Coh/1000 ft	8.0	4.6	1.77	9.3	6.1	2.34	9.0	5.5	2.12	7.7	4.7	1.81	6.7	4.1	1.58	2.6
Total suspended particulates,[b] $\mu g/m^3$	-	572	1.58	-	963	2.66	-	929	2.57	-	691	1.92	-	691	1.92	361
SO_2,[c] ppm	0.21	0.09	0.90	0.22	0.10	1.0	0.78	0.16	1.60	0.58	0.17	1.70	0.41	0.15	1.50	0.10
CO,[c] ppm	19.9	10.2	1.57	-	-	-	9.0	4.8	0.74	-	-	-	20.8	8.1	1.25	6.5
CO_2,[c] ppm	495	416	1.13	486	418	1.14	452	395	1.08	445	386	1.05	427	380	1.03	368
NO,[d] ppm	0.22	0.11	2.20	0.27	0.11	2.20	0.21	0.11	2.20	0.14	0.07	1.20	0.03	0.02	0.40	0.05
NO_2,[d] ppm	0.14	0.09	1.80	0.11	0.09	1.80	0.18	0.09	1.80	0.14	0.08	1.60	0.15	-	3.00	0.05
Aldehyde,[d] ppm	0.07	0.05	0.83	0.08	0.05	0.83	0.11	0.07	1.17	0.14	0.08	1.33	0.12	0.08	1.33	0.06

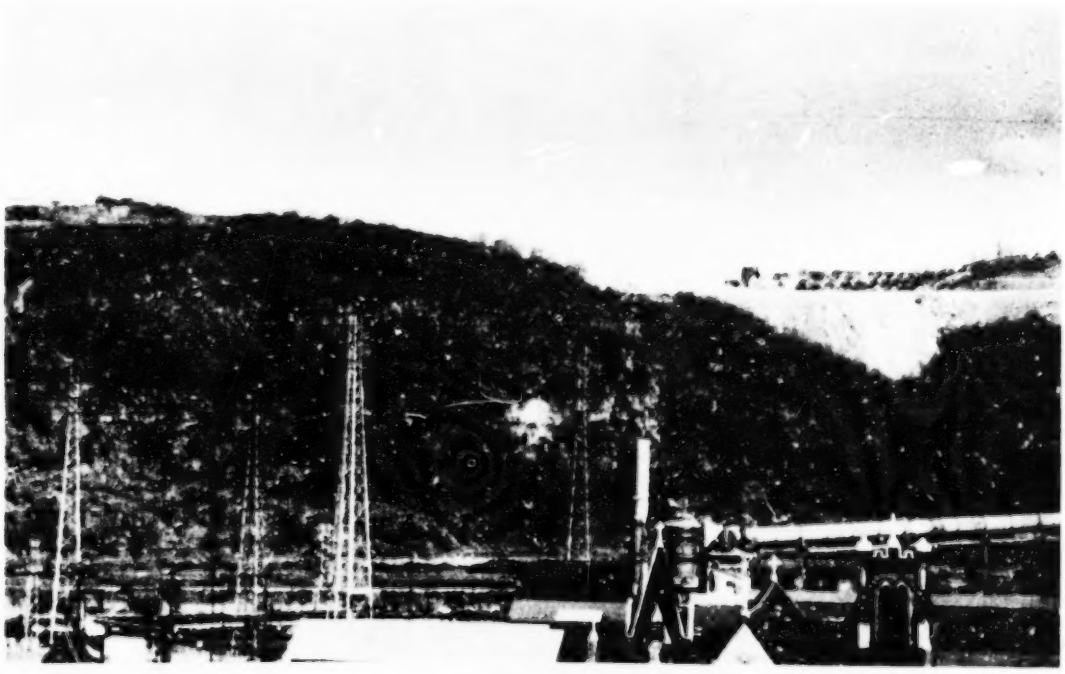
[a] 2-hour samples.

[b] 24-hour samples ending between 1500-1600 hours on date indicated.

[c] ½-hour average values from continuous recorders.

[d] 30-minute samples collected four times daily.

October 17, 1963, 1030 hours



October 24, 1963, 1500 hours

Figure 9. Effect of air pollution on visibility in Duquesne, Pa.

Representativeness of Meteorological Conditions During the Study

The meteorological observations used for estimating the representativeness of the sampling period are from the U. S. Weather Bureau Airport Station at the Greater Pittsburgh Airport. In general, it would be expected that wind speeds would be somewhat lower, and there would be more hours of calm in the Duquesne area than at the airport.

WIND SPEED

Wind speed is one of the most important meteorological factors in determining air pollution concentrations. Generally, the lower the wind speed, the greater the concentration. This effect is most pronounced at wind speeds of 7 miles per hour or less. High winds are not always beneficial, however, since local incidences of high pollution can occur from aerodynamic downwash of stack effluents when high winds occur.

Average wind speed for October 1963 was 6.3 mph at the Greater Pittsburgh Airport, whereas the normal speed is 7.8 mph for the period. Calm reported at the airport during the month, amounted to 195 hours or 26% of all observations. The expected percent frequency is 8%. The dilution potential of the atmosphere was lower than normal for the month of October; therefore, pollution levels would be higher than normal.

DEGREE-DAYS

Measurements of air temperature and heating degree-days are indicative of the production of air pollution by use of fuels for space heating. A degree-day is a measure of the departure of the mean daily temperature from a given standard, usually 65° F.

The month of October 1963, as a whole, had unusually high temperatures. The total number of degree-days was only 196, compared with the normal number of 375. The average temperature of 59°F for the month was the highest since 1949; therefore, pollutant emissions due to fuel use for space heating were much lower than normal.

PRECIPITATION

Precipitation is of interest because it washes out, or in the case of snow, scours out pollution. It also reduces wind-blown surface dust because the ground

becomes wet or frozen.

The total precipitation for the month (0.16 inch) made it the third driest October of record, and also the third driest month since records were begun in 1871. The normal amount of precipitation for October is 2.52 inches. The days with more than a trace of precipitation are shown below:

Date	3	27	29	31	Number of days:	4
Amount	0.01	0.02	0.03	0.10	Total amount:	0.16

The normal number of days in October with more than a trace of precipitation is 13; therefore, pollution levels during the study period were higher than normal because of lower than average precipitation.

VISIBILITY

Smoke or smoke and haze were reported at the Greater Pittsburgh Airport on the following days:

October 5, 6, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 25, and 26 - a total of 18 days. On the underlined days the condition lasted for 6 hours or more. Generally the smoke and/or haze reduced visibility to about 3 miles. The worst conditions, however, occurred on the 15th and 16th when 35 consecutive hours of smoke was reported. On the 15th the visibility was 1 mile with a relative humidity of 39%, and on the 16th it was 1-1/2 miles with a relative humidity of 42%.

Fog is generally considered to be a factor in reducing visibility when the relative humidity is 70% or more. Except for a few hours of ground fog scattered through the month, conditions were too dry for ordinary fog to occur. Practically all of the low visibility reported was caused by air pollution.

References

1. Hochheiser, S., M. Burchett and H. J. Dunsmore. Air Pollution Measurements in Pittsburgh. Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio. November 1963.

2. Hochheiser, S., M. Storlazzi and W. J. Basbagill. Use of a Mobile Laboratory in Air Pollution Studies. Presented at the Amer. Ind. Hyg. Assoc. Conference, Philadelphia, Pa. April 28, 1964.

3. Munroe, W. A. State-wide Air Pollution Survey, Smoke Index. Public Health News, 29:227, Trenton, N. J. 1958.

4. Air Pollution Measurements of the National Air Sampling Network. U.S. Department of Health, Education, and Welfare, Public Health Service Publication No. 978. Analyses of Suspended Particulates 1957-1961, Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio. 1962.

5. Oregon State Sanitary Authority. Pollution of Air, Chap. 449, Replacement Part, Portland, Oregon. March 1961.

6. Motor Vehicles, Air Pollution and Health, A Report of the Surgeon General to the U.S. Congress. 87th Congress, 2nd session. House Document No. 489. U.S. Government Printing Office, Washington. 1962.

7. Schueneman, J. J., M. D. High and W. E. Bye. Air Pollution Aspects of the Iron and Steel Industry. PHS Publ. 999-AP-1. Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio. 1963.

8. Saltzman, B. E. Colorimetric Microdetermination of Nitrogen Dioxide in the Atmosphere. Anal. Chem., 26:1949. 1954.

9. Bell, F. A. Meaningful Air Quality Measurements on a Limited Budget. J. Air Poll. Control Assoc., 13:127. 1963.

10. Hauser, T. R. and R. L. Cummins. Increasing the Sensitivity of the 3-Methyl-2 Benzothiazolone Hydrazone Test. Anal. Chem. 36:679. 1964.

11. Korshover, J. Synoptic Climatology of Stagnating Anti-cyclones East of the Rocky Mountains in the United States for the Period 1936-1956. Tech. Rep. A60-7. Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio. 1960.

Appendix - Tabulation of Air Pollution Measurements

Preceding page blank

Table A-1

PITTSBURGH-DUQUESNE,PENNSYLVANIA-OCTOBER,1963
FOURTH AND GRANT STREETS,DUQUESNE,PA.

SOILING INDEX
TRANSMITTANCE
UNITS= COH3/1000FT

	LOCAL TIME					
DAY	0	2	4	6	8	10
23						2.400
24	1.400	2.400	2.600	3.700	2.900	1.900
25	2.600	2.800	2.700	3.700	3.200	1.300
26	3.200	3.900	3.900	4.300	3.300	4.800
27	3.400	3.400	3.400	3.400	4.900	3.400
28	.900	.800	1.300	1.900	2.400	2.000
29	.800	1.300	2.900	2.900	.900	1.800
30	.800	1.400	1.300	2.800	2.200	1.300
1	3.400	2.300	2.400	2.500	3.000	3.300
2	3.500	3.500	3.800	4.300	3.400	1.300
3	1.400	.400	.900	.900		
4	.900	1.000	.900	1.000	1.000	.800
5	3.400	3.800	4.200	5.000	3.700	6.000
6	3.000	4.000	4.500	3.800	4.300	4.600
7	3.700	4.100	4.100	3.800	2.800	1.300
8	1.600	.700	.400	.500	.900	.800
9	1.500	1.600	2.000	3.500	5.000	2.000
10	3.400	1.800	4.600	7.300	7.300	3.700
11	4.700	4.300	3.700	4.500	4.300	3.000
12	1.100	.900	.700	1.900	1.300	.900
13	2.200	1.700	2.000	3.900	2.400	1.700
14	3.500	6.300	4.700	5.700	8.000	6.300
15	7.100	7.900	7.700	9.300		6.900
16	7.900	7.100	7.900	8.100	8.300	9.000
17	9.800	9.800	9.200	9.700	7.700	8.300
18	9.300	9.000	9.000	6.300	6.300	6.700
19	9.000	9.800	9.500	6.000	6.700	9.700
20	8.300	8.800	8.700	6.700	6.200	8.300
21	2.400	2.800	3.000	4.300	5.700	8.300
22	1.900	2.900	2.400	1.500	4.300	1.300
23	.900	.700	1.100	2.300	3.300	1.600
24	1.500	1.400	1.800	3.500	4.500	1.900
25	.500	1.300	2.300	3.200	4.500	2.400
26	4.300	3.300	4.100	4.700	4.900	4.200
27	2.600	3.300	2.900	2.700	2.800	2.800
28	.800	1.300	1.700	1.100	1.900	1.800
29	1.000	1.300	1.500	1.400		.900
30	1.400	1.900	1.300			
N1	2.862	3.035	3.127	3.936	4.300	3.139
N3	27	27	27	26	23	26
N4	7.300	7.900	7.700	9.300	8.300	9.000

N(1) = NO. OF VALID 2 HOUR SAMPLES
MAX(2) = PEAK 2 HOUR CONCENTRATION
N3 = DAYS WITH VALID 2 HOUR AVERAGES
N4 = PEAK 2 HOUR AVERAGES

Continued on next page

APD 81-6-11-4

Table A-1 (continued)

PITTSBURGH-DUQUESNE,PENNSYLVANIA-OCTOBER,1963
FOURTH AND GRANT STREETS,DUQUESNE,PA.

SCILING INDEX
TRANSMITTANCE
UNITS= COHS/1000FT

	LOCAL TIME								
DAY	12	14	16	18	20	22	AVG	N(1)	MAX(2)
23	1.300	2.400	1.500	5.200	5.700	2.700	3.057	7	9.700
24	.800	1.100	1.900	1.700	1.700	1.700	1.983	12	4.700
25	.800	1.100	.600	1.700	4.300	4.700	2.875	12	8.700
26	.900	.700	1.300	1.300	2.400	3.800	2.867	12	8.500
27	1.300	3.900	5.300	.900	1.100	1.300	3.100	12	5.500
28	1.800	1.100	.100	.100	1.300	1.300	1.250	12	2.400
29	.400	.800	.100	.300	.900	.800	1.117	12	2.900
30	.500	.500	.700	.700	1.300	2.900	1.367	12	2.900
1	2.600	.800	.700	1.700	2.400	4.200	2.608	12	9.000
2	.400	.500	.500	1.100	1.700	1.000	2.108	12	4.300
3	.500	.400	.700	.800	.500	.600	.670	10	1.400
4	.600	.800	.800	1.000	1.500	3.800	1.158	12	3.800
5	1.900	2.700	1.900	3.300	4.700	9.700	4.025	12	6.000
6	8.000	.400	.400	.800	.900	2.300	3.600	12	8.000
7	.800	.600	.700	.900	1.100	1.300	2.083	12	4.100
8	.600	.800	.400	1.100	1.100	.900	.783	12	1.600
9	.900	.500	.500	.900	2.600	3.400	2.033	12	9.000
10	1.700	1.500	1.900	2.300	2.400	3.800	3.692	12	7.900
11	1.300	.700	.900	1.600	2.200	1.400	2.733	12	8.700
12	1.100	.900	.800	.800	.800	1.000	.933	12	1.500
13	.700	.500	.900	1.300	1.100	2.200	1.883	12	3.500
14	2.900	1.900	1.700	3.000	4.900	8.700	4.033	12	8.000
15	5.200	2.400	2.900	4.900	6.300	6.900	6.136	11	9.300
16	3.900	1.700	1.100	2.500	3.500	5.300	3.475	12	9.000
17	3.400	2.000	1.900	2.700	5.000	4.900	4.700	12	7.700
18	3.000	1.300	1.300	1.700	2.300	4.200	4.050	12	8.700
19	4.200	1.900	.400	1.100	1.900	3.000	3.933	12	8.700
20	2.300	1.300	.800	.700	1.600	2.900	2.633	12	4.700
21	2.700	1.300	1.300	2.200	2.600	2.900	2.892	12	5.700
22	1.100	1.100	1.900	1.100	1.100	1.600	1.775	12	4.300
23	1.500	.700	.300	1.700	1.700	1.900	1.458	12	3.300
24	1.100	.200	.400	.900	1.300	.900	1.017	12	4.300
25	1.300	.900	.700	1.900	3.200	4.500	2.242	12	4.500
26	1.900	.700	.800	.900	1.100	2.300	2.783	12	8.900
27	2.900	.800	1.300	1.300	.900	.900	2.983	12	9.500
28	.800	.300	.900	.900	.500	.900	1.058	12	1.800
29	1.100	1.600	.900	1.900	.800	.800	1.209	11	1.900
30							1.933	3	1.960
AVG	1.849	1.205	1.078	1.984	2.178	2.710			
N3	37	37	37	37	37	37			
N4	8.000	9.500	5.300	5.200	6.300	8.900			

N(1) = NO. OF VALID 2 HOUR SAMPLES
MAX(2) = PEAK 2 HOUR CONCENTRATION
N3 = DAYS WITH VALID 2 HOUR AVERAGES
N4 = PEAK 2 HOUR AVERAGES

Arithmetic mean, all samples - 2.6

Geometric mean, all samples - 1.9

Table A-2. TOTAL SUSPENDED PARTICULATES

Date, 1963	Concentration, $\mu g/m^3$
September	
27	212
28	298
29	156
30	99
October	
1	248
2	321
3	178
4	122
5	416
6	413
7	265
8	146
9	204
10	417
11	379
12	184
13	187
14	572
15	963
16	929
17	691
18	691
20	524
21	617
22	358
23	227
24	199
25	338
29	1[illegible]
Arithmetic mean	361
Geometric mean	298
Maximum	963
Minimum	99

Table A-3

PITTSBURGH-DUQUESNE, PENNSYLVANIA-OCTOBER, 1963
FOURTH AND GRANT STREETS, DUQUESNE, PA

SULFUR DIOXIDE
ELECTROCONDUCTIVITY-AUTOMATIC MONITORING
UNITS= PPM

	LOCAL TIME											
DAY	0	1	2	3	4	5	6	7	8	9	10	11
27	.107	.104	.106	.111	.118	.107	.081	.057	.068	.181	.319	.387
28	.095	.098	.104	.092	.092	.086	.101	.105	.079	.241	.265	.269
29	.065	.069	.097	.081	.052	.049	.044	.043	.039	.031	.040	.051
30	.016	.018	.013	.015	.018	.017	.006	.008	.010	.068	.029	.008
1	.056	.087	.080	.051	.026	.027	.022	.021	.039	.116	.358	.306
2	.152	.092	.090	.077	.068	.073	.085	.088	.084	.170	.231	.110
3	.357	.299	.268	.156	.088	.073	.073	.076	.083	.051	.032	.029
4	.046	.047	.055	.054	.057	.055	.051	.039	.049	.059	.045	.033
5	.092	.096	.106	.127	.209	.148	.081	.062	.079	.123	.139	.137
6	.098	.086	.128	.101	.087	.056	.060	.059	.049	.055	.092	.386
7	.287	.222	.166	.125	.122	.118	.105	.124	.277	.265	.266	.143
8	.201	.213	.159	.085	.091	.068	.055	.064	.059	.043	.043	.032
9	.055	.054	.056	.064	.058	.048	.077	.060	.081	.094	.088	.053
10	.073	.086	.070	.069	.069	.092	.082	.084	.087	.101	.160	.443
11	.094	.109	.105	.099	.090	.066	.068	.089	.077	.091	.108	.183
12	.090	.093	.093	.078	.060	.060	.050	.057	.053	.070	.099	.071
13	.030	.034	.039	.057	.091	.046	.031	.045	.060	.047	.016	.008
14	.078	.084	.094	.083	.103	.150	.182	.187	.207	.204	.149	.141
15	.006	.011	.013	.015	.026	.030	.034	.037	.050	.060	.083	.113
16	.187	.172	.171	.190	.138	.145	.121	.102	.083	.117	.239	.364
17	.174	.172	.183	.177	.122	.126	.115	.139	.132	.232	.413	.359
18	.238	.374	.186	.140	.122	.134	.133	.119	.119	.108	.176	.224
19	.116	.109	.100	.098	.093	.088	.085	.080	.074	.146	.160	.112
20	.102	.102	.100	.094	.079	.079	.077	.070	.067	.069	.066	.064
21	.093	.088	.088	.082	.079	.073	.068	.064	.068	.237	.225	.149
22	.129	.128	.124	.124	.125	.156	.144	.120	.119	.066	.048	.047
23	.070	.072	.068	.063	.062	.059	.066	.079	.080	.082	.054	.079
24	.107	.105	.104	.107	.111	.104	.113	.118	.119	.073	.089	.158
25	.113	.110	.104	.108	.112	.105	.103	.115	.104	.083	.237	.153
26	.143	.141	.156	.192	.132	.126	.145	.113	.109	.144	.659	.278
27	.234	.618	.287	.194	.161	.143	.109	.098	.127	.117	.227	.328
28	.066	.055	.059	.050	.051	.066	.051	.059	.065	.054	.046	.047
29	.027	.019	.014	.014	.014	.017	.013	.007	.007	.004	.012	.016
AVG	.115	.114	.108	.095	.088	.085	.080	.078	.085	.109	.158	.171
N3	33	33	33	33	33	33	33	33	33	33	33	33
M4	.357	.374	.287	.194	.209	.159	.182	.187	.277	.665	.659	.364

N(1) = HOURS OF VALID DATA
MAX(2) = PEAK 30 MIN. CONCENTRATION
N3 = DAYS WITH VALID HOURLY AVERAGES
M4 = PEAK HOURLY AVERAGES

Continued on next page

Table A-3 (continued)

PITTSBURGH-DUQUESNE, PENNSYLVANIA-OCTOBER, 1953
FOURTH AND GRANT STREETS, DUQUESNE, PA

SULFUR DIOXIDE
ELECTROCONDUCTIVITY-AUTOMATIC MONITORING
UNITS: PPM

DAY	LOCAL TIME 12	13	14	15	16	17	18	19	20	21	22	23	AVG	N(1)	MAX(2)
27	.215	.088	.032	.040	.051	.048	.063	.078	.094	.099	.097	.090	.113	24	.410
28	.129	.087	.101	.061	.061	.060	.075	.096	.098	.128	.093	.079	.112	24	.286
29	.042	.040	.041	.044	.049	.047	.044	.037	.031	.023	.023	.017	.046	24	.106
30	.007	.012	.023	.031	.037	.042	.043	.040	.039	.035	.039	.046	.026	24	.068
1	.171	.049	.045	.057	.061	.071	.080	.073	.076	.107	.216	.235	.101	24	.420
2	.040	.036	.037	.041	.043	.057	.071	.083	.173	.329	.214	.291	.112	24	.338
3	.017	.020	.016	.017	.022	.028	.041	.033	.053	.053	.057	.059	.034	24	.090
4	.032	.042	.052	.028	.029	.032	.053	.045	.049	.051	.057	.078	.047	24	.075
5	.057	.061	.079	.072	.080	.095	.079	.104	.116	.130	.124	.114	.104	24	.228
6	.164	.061	.032	.041	.050	.061	.079	.091	.079	.075	.114	.266	.098	24	.400
7	.097	.064	.064	.065	.071	.088	.090	.090	.137	.276	.271	.193	.134	24	.339
8	.037	.021	.029	.027	.030	.037	.036	.042	.047	.040	.039	.037	.063	24	.242
9	.049	.031	.038	.037	.038	.037	.063	.057	.069	.073	.072	.074	.060	24	.096
10	.383	.148	.070	.067	.069	.083	.068	.080	.071	.090	.093	.093	.113	24	.360
11	.131	.082	.058	.083	.064	.066	.090	.098	.120	.145	.104	.099	.077	24	.219
12	.068	.061	.079	.097	.069	.059	.094	.072	.072	.043	.036	.031	.067	24	.104
13	.011	.007	.010	.010	.019	.025	.030	.032	.030	.042	.059	.070	.036	24	.093
14	.119	.089	.088	.097	.000	.000	.002	.002	.008	.008	.008	.008	.027	24	.209
15	.169	.138	.133	.119	.089	.091	.149	.171	.168	.179	.191	.218	.093	24	.218
16	.396	.191	.079	.062	.061	.073	.072	.088	.090	.106	.114	.159	.103	24	.775
17	.233	.222	.120	.088	.099	.069	.093	.112	.123	.134	.169	.189	.174	24	.377
18	.175	.169	.168	.106	.132	.134	.099	.128	.139	.128	.119	.120	.134	24	.407
19	.160	.124	.090	.130	.088	.066	.085	.093	.109	.103	.102	.100	.109	24	.179
20	.083	.070	.079	.077	.088	.092	.099	.103	.101	.101	.098	.097	.089	24	.194
21	.132	.113	.107	.109	.113	.104	.123	.158	.148	.142	.178	.187	.119	24	.238
22	.056	.082	.064	.061	.067	.121	.121	.135	.111	.105	.092	.083	.100	24	.198
23	.114	.070	.059	.072	.097	.101	.108	.116	.117	.117	.120	.112	.085	24	.143
24	.141	.115	.067	.064	.060	.077	.095	.117	.111	.120	.117	.116	.104	24	.173
25	.123	.201	.168	.084	.079	.084	.092	.109	.110	.130	.149	.149	.121	24	.392
26	.179	.086	.079	.079	.088	.100	.102	.106	.104	.114	.132	.208	.133	24	.718
27	.195	.218	.108	.110	.134	.089	.089	.098	.088	.069	.070	.067	.149	24	.447
28	.033	.023	.045	.045	.040	.050	.027	.041	.029	.030	.036	.029	.045	24	.072
29													.014	12	.091
AVG	.130	.087	.070	.067	.064	.069	.076	.089	.091	.104	.108	.111			
N3	32	32	32	32	32	32	32	32	32	32	32	32			
M4	.396	.222	.168	.150	.192	.134	.149	.171	.178	.329	.271	.260			

N(1) = HOURS OF VALID DATA
MAX(2) = PEAK 30 MIN. CONCENTRATION
N3 = DAYS WITH VALID HOURLY AVERAGES
M4 = PEAK HOURLY AVERAGES

Arithmetic mean, all samples - 0.10
Geometric mean, all samples - 0.08

Table A-4

PITTSBURGH DUQUESNE, PENNSYLVANIA-OCTOBER, 1963
FOURTH AND GRANT STREETS, DUQUESNE, PA.

CARBON MONOXIDE
NONDISPERSIVE INFRARED ANALYZER
UNITS= PPM

	LOCAL TIME											
DAY	0	1	2	3	4	5	6	7	8	9	10	11
28												
29	7.600	6.700	6.250	6.000	4.700	4.650	4.[illegible]00	4.750	4.550	4.350	4.650	4.[illegible]50
30	4.550	4.800	4.650	5.000	4.750	4.600	6.650	6.900	5.600	5.000	3.850	3.950
1	7.100	6.900	5.350	5.150	4.600	4.950	5.150	5.650	6.800	7.500	8.600	6.000
2	9.800	8.450	6.550	6.250	6.050							
3	7.150	7.150	6.350	6.300	6.300	6.250	6.200	6.900	8.000	4.900	4.000	3.950
4	4.850	4.450	4.600	4.250	3.850	4.100	4.050	3.700	3.450	2.950	2.750	2.650
5	7.200	5.450	6.500	4.850	4.750	5.150	5.850	5.350	5.050	6.850	13.050	8.500
6	11.900	7.300	6.950	7.250	6.600	5.700	6.800	9.150	6.750	4.250	6.600	5.550
7	8.100	9.250	6.800	7.650	7.300	7.300	6.300	7.050	6.500	5.750	4.900	4.400
8	7.500	5.500	5.150	5.250	5.050	5.100	4.950	4.650	5.500	4.800	5.350	4.700
9	4.900	5.050	4.300	4.700	4.800	5.050	5.850	9.300	9.000	8.300	5.850	4.300
10	10.350	7.850	6.300	5.950	5.900	5.300	7.550	11.000	10.750	8.600	7.150	6.350
11	8.300	9.850	7.850	6.850	5.850	4.850	6.450	8.700	6.850	6.750	6.450	4.700
12	6.300	5.500	5.800	5.100	5.200	4.800	4.[illegible]00	4.700	5.150	4.500	4.400	4.150
13	4.350	4.750	4.600	4.100	2.900	3.900	4.600	4.500	3.900	2.650	2.850	6.600
14	10.800	9.600	10.000	9.500	9.800	9.550	11.700	14.550	14.100	10.250	7.300	12.250
15	12.900	12.750	12.100	11.400	10.150	9.000	8.[illegible]00	9.550	13.100	14.200	14.400	
16												8.050
17												
18	14.050	10.700	11.300	12.300	13.650	11.150	9.250	9.800	8.200	10.150	8.700	10.100
19	12.750	9.800	8.150	7.150	6.900	6.750	7.[illegible]00	7.950	6.100	4.800	4.250	5.500
20	5.800	6.150	5.250	5.900	5.650	5.800	6.500	7.300	8.200	5.950	5.950	5.300
21	3.550	3.350	3.500	3.550	3.600	3.100	4.550	10.300	15.300	10.150	4.200	3.700
22	5.100	5.100	4.700	5.100	4.750	2.600	4.650	5.250	5.400	5.200	4.000	3.500
23	6.800	4.750	5.[illegible]00	5.000	5.600	4.900	4.250	4.100	5.050	3.450	2.100	
24	4.050	4.400	4.000	5.900	6.350	7.050	[illegible].550	16.550	20.500	19.900	10.900	
25												4.900
26												
27	11.000	12.250	13.400	14.200	15.300	15.250	15.350	16.900	16.900	9.350		
AVG	7.870	7.098	6.656	6.586	6.414	6.127	6.717	8.[illegible]06	8.363	7.327	6.167	5.634
N3	25	25	25	25	25	24	24	24	24	24	23	22
M4	14.050	12.750	13.400	14.200	15.300	15.250	15.350	16.900	20.500	19.900	14.400	12.250

N(1) = HOURS OF VALID DATA
MAX(2) = PEAK 30 MIN. CONCENTRATION
N3 = DAYS WITH VALID HOURLY AVERAGES
M4 = PEAK HOURLY AVERAGES

Continued on next page

Table A-4 (continued)

PITTSBURGH-DUQUESNE, PENNSYLVANIA-OCTOBER, 1963
FOURTH AND GRANT STREETS, DUQUESNE, PA.

CARBON MONOXIDE
NONDISPERSIVE INFRARED ANALYZER
UNITS= PPM

	LOCAL TIME														
DAY	12	13	14	15	16	17	18	19	20	21	22	23	AVG	N(1)	MAX(2)
28	9.350	9.750	9.600	9.550	5.750	6.650	6.300	8.200	8.850	7.650	9.400	7.650	8.892	12	9.900
29	4.750	9.600	9.450	4.300	4.700	4.400	3.700	3.850	4.050	4.100	4.850	3.100	4.850	24	8.200
30	4.600	4.850	9.200	9.950	9.900	6.300	6.050	6.200	6.600	6.800	7.900	8.100	9.993	24	8.900
1	9.450	9.900	4.750	4.700	7.250	9.400	9.050	7.050	9.050	9.100	8.400	8.600	8.952	24	9.800
2	9.050	9.000	9.150	9.750	5.750	6.850	6.750	7.200	7.450	7.700	7.150	7.000	8.688	17	9.800
3	3.400	3.100	2.750	2.650	2.850	3.450	3.600	4.900	4.650	4.900	4.900	4.950	4.965	24	8.100
4	2.800	2.950	3.500	3.500	3.100	2.450	2.300	3.850	5.700	6.150	7.450	6.650	5.994	24	8.400
5	3.350	5.000	4.350	4.600	4.650	3.350	4.250	9.700	11.200	12.350	12.800	15.350	7.996	24	18.000
6	4.100	4.800	3.350	3.500	3.400	5.150	5.250	6.450	6.000	5.400	6.750	10.000	6.223	24	16.900
7	4.600	4.500	4.350	4.300	4.600	4.900	5.650	5.750	6.050	6.250	6.200	7.750	6.083	24	10.100
8	4.800	4.900	4.600	4.850	4.950	5.100	4.850	5.500	5.400	5.100	5.200	5.000	5.102	24	7.700
9	3.950	3.150	3.250	3.750	4.250	4.900	4.800	4.450	10.250	8.450	8.900	8.800	5.842	24	12.100
10	5.400	4.400	3.550	4.950	5.000	5.950	6.300	6.050	9.350	12.500	18.600	18.100	8.942	24	21.400
11	5.450	5.800	5.900	5.850	6.850	6.450	7.050	7.950	8.800	7.950	8.350	8.300	8.740	24	10.100
12	3.700	4.000	4.400	4.600	4.400	4.650	3.800	3.950	3.000	3.400	3.400	3.600	4.471	24	6.900
13	8.300	4.700	6.000	5.950	5.050	2.750	4.350	6.050	9.800	8.350	8.950	8.100	5.344	24	10.300
14	10.250	7.150	5.000	5.900	5.400	6.850	5.950	8.750	13.450	11.800	17.100	13.600	10.192	24	19.900
15													11.650	11	19.300
16	8.250	5.750	5.300	5.450	4.400	3.150	4.300						4.829	7	9.000
18	4.750	5.350	5.000	5.400	5.100	5.850	5.950	8.850	9.850	9.800	14.750	16.300	8.077	13	20.800
19	8.150	4.800	4.950	5.000	4.900	5.600	7.700	7.800	9.850	9.400	12.350	16.400	9.327	24	18.300
20	5.900	5.050	5.600	5.500	5.100	5.450	6.050	6.900	8.300	7.350	8.100	9.800	6.388	24	19.200
21	5.450	5.950	5.600	6.050	4.200	5.300	6.950	6.400	6.250	6.200	6.050	4.600	5.456	24	8.900
22	2.750	5.050	4.250	4.650	4.900	8.900	10.450	9.300	8.950	8.350	8.200	8.750	6.131	24	19.300
23	2.950	2.700	2.600	2.350	3.150	3.600	4.700	7.450	10.450	8.950	7.950	8.950	5.873	24	11.000
24	4.700	5.050	5.950	6.000	6.300	7.100	9.300	7.000	6.300	4.950	5.150	5.100	5.952	23	8.700
25													9.795	11	21.000
26	4.400	4.400	2.750	3.600	4.950	5.950	6.450	8.700	8.850	9.700	10.450	11.850	6.996	13	18.600
29													13.990	10	18.100
AVG	4.877	4.463	4.167	4.533	4.844	5.156	5.470	6.818	7.858	7.810	8.464	8.628			
N3	26	26	26	26	26	26	26	25	25	25	25	25			
N4	10.250	7.150	6.000	5.950	7.450	8.900	10.450	9.700	13.450	12.800	18.600	18.300			

N(1) = HOURS OF VALID DATA
MAX(2) = PEAK 30 MIN. CONCENTRATION
N3 = DAYS WITH VALID HOURLY AVERAGES
N4 = PEAK HOURLY AVERAGES

Arithmetic mean, all samples - 6.5
Geometric mean, all samples - 5.9

Table A-5

PITTSBURGH-DUQUESNE, PENNSYLVANIA-OCTOBER, 1983
FOURTH AVE GRANT STREETS, DUQUESNE, PA.

CARBON DIOXIDE
NONDISPERSIVE INFRARED ANALYZER
UNITS= PPM

	LOCAL TIME											
DAY	0	1	2	3	4	5	6	7	8	9	10	11
26	380,000	392,000	393,000	398,500	409,500	418,500	425,500	429,000	422,000	396,500	406,000	397,000
27	379,000	384,000	389,000	394,000	396,500	398,000	380,500	385,500	387,000	399,000	410,500	396,500
28												389,000
29	367,000	366,500	366,500	369,000	362,000	364,000	364,000	363,500	369,500	361,500	372,000	366,500
30	389,500	388,000	399,000	412,000	417,500	415,000	413,000	432,000	413,000	361,500	359,500	358,000
1	381,000	385,000	379,500	376,000	377,500	377,000	379,000	381,000	384,000	394,500	377,500	352,500
2	379,500	374,000	379,500	376,500	388,000	388,500	396,000	395,000	380,500	387,500	352,000	349,000
3	337,500	330,000	329,000	317,500	316,000	317,500	321,500	332,500	349,000	345,000	347,000	348,000
4	335,000	341,500	343,500	342,000	347,500	346,500	350,500	348,500	347,000	349,000	336,000	339,500
5	388,500	388,000	398,500	409,500	417,500	418,500	417,500	423,000	416,000	399,000	391,500	380,500
6	382,500	397,500	410,000	412,500	410,000	416,000	423,500	428,500	406,000	393,500	422,500	387,000
7	372,500	377,000	370,000	373,000	375,000	382,000	375,000	403,000	389,500	373,500	354,500	334,500
8	348,000	339,000	331,000	334,500	334,000	329,000	333,500	331,500	337,500	338,500	343,500	347,500
9	349,500	359,000	359,000	370,000	379,000	383,500	390,000	411,500	397,000	390,500	375,000	359,500
10	386,000	386,000	389,000	395,000	399,000	413,500	424,000	426,500	419,000	393,000	388,500	385,500
11	368,500	389,000	389,000	389,500	387,000	378,500	386,500	388,500	381,000	375,000	369,500	357,500
12	341,000	340,000	339,500	346,000	343,000	346,000	348,500	350,500	343,500	329,000	326,500	319,500
13	363,500	378,500	388,000	393,500	397,500	411,500	418,500	418,000	410,500	386,500	374,000	376,000
14	430,000	440,500	459,000	452,000	454,500	470,000	480,000	470,500	495,000	457,500	441,000	442,500
15	424,000	438,500	448,500	457,000	466,500	472,500	484,000	478,500	476,500	459,000	421,500	422,500
16	419,000	426,000	429,500	426,000	436,500	432,000	438,000	441,500	443,500	431,000	438,500	437,500
17	399,000	394,500	406,000	401,000	387,500	392,000	400,000	410,000	423,000	439,000	439,500	398,000
18	392,000	401,000	394,000	395,000	387,500	398,500	419,500	424,000	422,500	407,000	399,000	412,500
19	389,000	395,500	409,500	407,500	422,500	411,000	409,000	406,000	420,000	399,500	395,500	389,000
20	389,000	381,000	373,500	377,000	373,500	374,500	384,000	393,500	396,000	364,500	362,500	367,000
21	359,500	367,000	364,500	368,500	373,000	374,000	384,500	396,000	403,500	403,000	392,000	370,000
22	347,000	346,000	351,500	354,500	358,000	367,000	387,500	394,500	412,000	390,500	367,000	360,500
23	339,500	337,500	339,500	344,000	346,000	352,000	374,000	384,500	386,500	389,500	379,000	358,500
24	350,500	340,000	350,000	348,500	363,000	372,500	373,000	393,500	409,000	379,000	358,000	
25	328,500	331,500	340,000	337,500	352,000	350,000	358,000	383,500	384,000	373,000	372,000	359,500
26	397,500	389,500	392,000	397,000	391,000	400,500	411,500	405,000	404,500	399,000	418,500	391,500
27	382,500	387,500	393,000	388,000	387,000	390,000	398,000	384,500	393,500	383,500	400,000	373,000
28	357,000	360,500	362,000	364,000	367,000	369,000	369,500	371,000	378,500	380,000	370,000	357,500
29	364,500	369,500	363,000	369,000	383,500	369,000	373,000	378,000	375,000	370,500	340,000	
AVG	372,879	376,333	378,742	381,500	385,019	387,818	393,712	398,803	399,185	387,391	382,182	374,156
N3	33	33	33	33	33	33	33	33	33	33	33	32
M4	430,000	440,500	459,000	457,000	466,500	472,500	484,000	478,500	495,000	457,500	441,000	442,500

N(1) = HOURS OF VALID DATA
MAX(2) = PEAK 30 MIN. CONCENTRATION
N3 = DAYS WITH VALID HOURLY AVERAGES
M4 = PEAK HOURLY AVERAGES

Continued on next page

Table A-5 (continued)

PITTSBURGH-DUQUESNE,PENNSYLVANIA-OCTOBER,1963
FOURTH AVN GRANT STREETS,DUQUESNE,PA.

CARBON DIOXIDE
NONDISPERSIVE INFRARED ANALYZER
UNITS: PPM

	LOCAL TIME														
DAY	12	13	14	15	16	17	18	19	20	21	22	23	AVG	N(1)	MAX(2)
26	361,500	341,000	366,500	392,500	335,000	332,500	336,000	339,000	345,500	361,000	370,000	377,000	379,875	24	437,000
27	373,000	338,500	339,000	332,000									380,000	16	418,000
28	377,000	368,500	369,000	358,500	357,000	356,500	353,000	364,000	366,000	369,500	371,000	364,500	369,731	13	389,000
29	350,500	348,500	346,000	348,500	358,000	361,000	366,500	367,000	371,500	367,000	370,500	374,500	363,313	24	378,000
30	347,500	342,500	339,500	332,500	329,000	329,000	328,500	330,500	344,500	347,500	359,500	367,000	369,146	24	439,000
1	343,000	347,000	348,500	341,500	342,000	339,500	342,000	352,000	368,500	377,500	379,000	391,500	367,146	24	400,000
2	330,000	327,500	326,500	323,500	320,000	319,000	317,000	317,500	341,500	336,000	327,500	333,000	332,583	24	397,000
3	352,000	347,500	348,000	346,500	341,000	334,500	339,000	331,000	331,000	333,500	337,500	338,500	339,813	24	399,000
4	342,500	338,500	339,500		341,000	341,500	331,000	335,000	341,500	352,500	369,500	375,500	348,938	23	380,000
5	346,000	351,000	350,000	343,500	341,500	329,000	343,500	369,000	372,500	386,500	401,500	407,500	382,813	24	425,000
6	334,500	337,500	331,500	328,500	321,000	318,500	325,000	327,500	323,000	327,500	359,500	371,500	371,629	24	433,000
7	333,000	328,500	328,000	325,000	323,000	318,000	316,500	320,000	329,000	333,500	338,500	349,500	339,833	24	408,000
8	343,000	337,500	338,000	334,000	330,500	331,000	328,500	339,000	338,000	338,500	343,500	346,000	337,042	24	369,000
9	344,000	341,500	336,500	339,000	334,500	335,000	332,500	333,500	346,000	362,000	368,000	371,500	361,063	24	412,000
10	348,000	349,500	349,000	343,500	347,000	337,000	341,500	344,000	365,000	378,500	387,000	385,000	378,000	24	433,000
11	353,000	342,500	341,500	339,500	332,500	330,000	333,000	338,500	344,000	347,000	342,500	343,500	340,688	24	399,000
12	319,500	314,500	304,500	296,000	312,000	326,000	335,000	338,500	339,000	342,500	349,000	354,000	333,965	24	355,000
13	373,500	369,000	367,000	361,000	353,000	351,000	358,500	371,000	379,000	388,500	402,000	418,500	383,292	24	424,000
14	401,000	371,500	349,000	349,500	345,500	352,000	364,500	378,500	389,500	397,000	394,000	419,000	416,146	24	495,000
15	411,500	3[illegible]7,500	361,000	352,000	346,000	361,500	371,500	388,500	396,000	403,000	420,000	411,500	417,958	24	466,000
16	395,000	361,500	349,000	329,000	333,500	335,000	337,500	351,500	363,500	378,500	381,500	393,000	399,479	24	432,000
17	384,500	369,000	364,500	341,000	336,000	338,000	356,500	364,000	369,000	389,500	389,500	400,000	386,208	24	449,000
18	374,500	371,000	356,500	349,000	333,000	330,500	338,500	347,500	349,000	357,000	382,500	378,500	379,500	24	427,000
19	378,500	370,000	348,000	332,000	327,500	324,500	328,000	329,500	347,000	348,000	358,500	374,500	379,375	24	429,000
20	369,000	342,500	330,000	322,500	317,500	315,500	327,500	331,500	337,500	345,500	353,000	352,500	357,471	24	400,000
21	358,500	352,500	349,000	342,000	336,500	332,000	333,000	349,500	349,500	351,000	358,500	348,500	362,625	24	407,000
22	354,500	359,000	345,000	347,000	341,500	372,500	382,500	374,000	369,000	369,500	361,500	338,500	369,521	24	417,000
23	357,500	353,000	341,000	339,000	339,000	337,500	341,500	357,000	352,000	343,000	341,000	342,500	339,104	24	393,000
24	345,000	351,500	346,000	353,000	334,000	331,000	325,500	339,500	334,500	339,000	332,000	331,000	331,729	23	410,000
25	349,500	337,500	346,500	331,000	325,000	330,000	335,500	343,000	353,500	378,000	390,500	401,000	353,604	24	402,000
26	363,000	347,000	336,000	331,000	331,000	335,500	339,500	346,000	346,000	370,000	371,000	385,500	370,792	24	427,000
27	361,500	350,000	344,500	338,500	349,000	358,500	359,500	373,000	358,500	353,000	367,500	359,500	372,229	24	402,000
28	358,000	362,500	359,500	351,000	340,000	340,500	348,500	352,000	352,500	353,500	359,500	364,000	360,021	24	387,000
29													388,636	11	397,000
AVG	359,000	349,076	343,515	340,219	335,906	336,984	340,547	348,063	353,266	359,914	368,172	370,629			
N3	33	33	33	32	32	32	32	32	32	32	32	32			
M4	411,500	371,500	367,000	392,500	358,000	372,500	386,500	388,500	396,000	403,000	420,000	418,500			

N(1) = HOURS OF VALID DATA
MAX(2) = PEAK 30 MIN. CONCENTRATION
N3 = DAYS WITH VALID HOURLY AVERAGES
M4 = PEAK HOURLY AVERAGES

Arithmetic mean, all samples - 368

Geometric mean, all samples - 366

GPO 816-111-3

Table A-6. NITRIC OXIDE CONCENTRATIONS
(ppm by volume)

Date, 1963	Time[a]			
	0830	1030	1330	1530
September				
28	0.06	0.09	0.03	--
October				
1	0.11	0.16	0.02	0.02
2	0.14	0.04	0.01	0.01
3	0.02	0.01	0.01	0.01
4	0.03	0.01	0.01	0.01
5	0.16	0.16	0.03	0.02
7	0.11	--	0.01	0.01
8	0.02	0.01	0.01	0.01
9	0.16	0.04	0.04	0.01
10	0.26	0.15	0.01	0.01
11	0.08	0.06	0.01	0.01
12	0.02	0.02	<0.01	0.01
14	0.22	0.16	0.04	0.02
15	0.27	0.12	0.02	0.01
16	0.21	0.20	0.03	0.01
17	0.10	0.14	0.02	0.01
18	0.03	0.03	0.01	--
19	0.16	0.12	0.04	0.01
21	0.03	0.02	0.03	<0.01
22	0.13	0.01	0.02	<0.01
23	0.01	--	--	0.01
24	--	0.01	0.02	--
25	0.21	0.03	0.02	0.01
28	--	0.03	0.01	0.01
29	0.02	--	--	--
Maximum	0.27	0.20	0.04	0.02
Arithmetic mean	0.11	0.07	0.02	0.01

Arithmetic mean, all samples - 0.05
Geometric mean, all samples - 0.03

[a] 30-minute samples beginning at the time indicated.

Table A-7. NITROGEN DIOXIDE CONCENTRATIONS
(ppm by volume)

Date, 1963	Time[a]			
	0830	1030	1330	1530
September				
28	0.06	0.07	0.06	--
October				
1	0.04	0.06	0.03	0.03
2	0.06	0.04	0.01	0.01
3	0.04	0.02	0.02	0.02
4	0.02	0.01	0.02	0.02
5	0.05	0.09	0.06	0.06
7	0.07	--	0.02	0.01
8	0.02	0.02	0.01	0.01
9	0.03	0.04	0.03	0.01
10	0.07	0.08	0.04	0.05
11	0.06	0.06	0.03	0.03
12	0.02	0.02	0.01	0.01
14	0.07	0.14	0.07	0.06
15	0.09	0.11	0.07	0.07
16	0.09	0.18	0.06	0.03
17	0.07	0.14	0.07	0.04
18	0.05	--	0.15	--
19	0.09	0.08	0.14	0.05
21	0.08	0.08	0.08	0.02
22	0.09	0.02	0.02	0.02
23	0.03	0.02	--	--
24	--	0.03	0.03	0.01
25	0.09	0.06	0.05	0.03
28	0.03	0.01	0.02	0.02
29	0.04	--	--	--
Maximum	0.09	0.18	0.15	0.07
Arithmetic mean	0.06	0.06	0.05	0.03

Arithmetic mean, all samples - 0.05
Geometric mean, all samples - 0.04

[a]30-minute samples beginning at the time indicated.

Table A-8 TOTAL ALIPHATIC ALDEHYDE CONCENTRATIONS
(ppm by volume as formaldehyde)

Date, 1963	Time[a]			
	0830	1030	1330	1530
September 28	0.05	0.08	0.02	-
October 1	0.05	0.07	0.05	0.02
2	0.06	0.02	0.02	0.03
3	0.02	0.03	0.02	0.02
4	0.19	0.07	0.06	0.03
5	0.13	0.08	0.07	0.05
7	0.03	-	0.03	0.02
8	0.04	0.02	-	0.04
9	0.07	0.04	0.04	0.03
10	0.13	0.06	0.04	<0.01
11	0.13	0.03	0.01	0.02
12	0.10	0.06	0.07	0.04
14	0.07	0.04	0.05	0.02
15	0.08	0.05	0.03	0.04
16	0.10	0.11	0.05	0.03
17	0.14	0.06	0.05	0.05
18	0.12	0.06	-	0.05
19	0.10	0.06	0.03	0.04
21	0.18	0.06	0.06	0.04
22	0.13	0.04	0.04	0.04
23	0.09	-	-	0.07
24	-	0.15	0.15	0.02
25	0.12	0.03	0.02	0.04
28	0.04	0.07	0.03	0.09
29	0.10	-	-	-
Maximum	0.19	0.15	0.15	0.09
Arithmetic mean	0.09	0.06	0.05	0.04

Arithmetic mean, all samples - 0.06
Geometric mean, all samples - 0.05

[a] 30-minute samples beginning at the time indicated.

Table A-9. SAMPLING AND ANALYTICAL PROGRAM - MOBILE AIR-SAMPLING LABORATORY

Pollutant	Apparatus	Sampling interval, hr	Sampling rate, liters/minute	Frequency of sample collection/day	Analytical method
Sulfur dioxide	(1) Automatic monitoring[a]	Continuous	3.0	Continuous	Electroconductivity
	(2) Midget impinger with and without inline glass fiber or membrane prefilter	½	2.0	4	West-Gaeke
	(3) Large impinger, with and without inline glass fiber or membrane prefilter	½	20.0	4	Hydrogen peroxide
	(4) Automatic monitoring - nonrecording[a]	Continuous	10.0	Continuous	Photometric
Oxidants	(1) Automatic monitoring[a]	Continuous	0.14	Continuous	Coulometric
	(2) Midget impinger	½	1.0	4	Neutral potassium iodide
	(3) Midget impinger	½	1.0	4	(1) Phenolphthalin, spectrophotometric (2) Phenolphthalin, visual color comparator
	(4) Midget impinger	½	2.0	4	Sodium diphenylamine sulfonate
Nitrogen dioxide	(1) Automatic monitoring[a]	Continuous	0.29	Continuous	Photometric
	(2) Large, fritted bubbler	24	0.4	1	Saltzman
	(3) Large, fritted bubbler	24	0.4	1	Jacobs-Hochheiser
Nitric oxide and nitrogen dioxide	(1) Fritted bubbler[11]	½	0.4	4	Saltzman,
	(2) Fritted bubbler	½	0.4	4	Jacobs-Hochheiser
Carbon monoxide	(1) Automatic monitoring[a]	Continuous	1.0	Continuous	Nondispersive, infra-red absorption
	(2) Detector tube	1/120 to ½	0.10	4	Colorimetric
	(3) Detector tube	1/120 to ½	0.03	4	Length of stain
Carbon dioxide	Automatic monitoring[a]	Continuous	1.0	Continuous	Nondispersive, infrared absorption
Aldehydes	Fritted bubbler	1	1.0	4	MBTH
Soiling index	Filter paper tape sampler	2	6.0	Continuous	(1) Density of stain - light transmittance (2) Density of stain - light reflectance
Suspended particulates	High-volume sampler	24	50 cfm	1	Gravimetric (analyses of the organic and inorganic fraction may be performed)

[a] Commercially available instruments.

GPO 814-111-2